



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

**PHARMACEUTICAL ENGINEERING
(R23-IInd YEAR COURSE STRUCTURE & SYLLABUS)**

B.Tech.– II Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	BS	Mathematics – III (Biostatistics)	3	0	0	3
2	HSMC	Universal human values – understanding harmony and Ethical human conduct	2	1	0	3
3	Engineering Science	Engineering Mechanics	3	0	0	3
4	Professional Core	Pharmaceutical Engineering– I	3	0	0	3
5	Professional Core	Thermodynamics for pharmaceutical engineers	3	0	0	3
6	Professional Core	Engineering Mechanics Lab	0	0	3	1.5
7	Professional Core	Pharmaceutical Engineering – I lab	0	0	3	1.5
8	Skill Enhancement Course	Soft skills	0	1	2	2
9	Audit Course	Environmental Science	2	0	0	-
Total			15	2	10	20

B.Tech. II Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Management Course- I	Managerial Economics and Financial Analysis	2	0	0	2
2	Engineering Science/ Basic Science	Reaction Engineering for Pharmaceutical Engineers	3	0	0	3
3	Professional Core	Heat Transfer for Pharmaceutical Engineers	3	0	0	3
4	Professional Core	Physical Pharmaceutics	3	0	0	3
5	Professional Core	Principles of Microbiology and Biochemistry	3	0	0	3
6	Professional Core	Physical Pharmaceutics Lab	0	0	3	1.5
7	Professional Core	Microbiology and Biochemistry lab	0	0	3	1.5
8	Skill Enhancement course	Organisational Behaviour	0	1	2	2
9	Engineering Science	Design Thinking & Innovation	1	0	2	2
Total			15	1	10	21
Mandatory Community Service Project Internship of 08weeks duration during summer Vacation						



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II Year – I Semester

MATHEMATICS – III (BIostatISTICS)

L	T	P	C
3	0	0	3

PRE-REQUISITE: Biostatistics

COURSE OBJECTIVES: Upon completion of the course the student shall be able to

- Know the operation of M.S.Excel, R,DoE (Design of Experiment)
- Know the various statistical techniques to solve statistical problems
- Appreciate statistical techniques in solving the problems.

COUSRE OUTCOMES:

- Understand basic statistical concepts and their applications in biology and related fields.
- Apply descriptive statistics techniques to summarize and visualize data sets.
- Interpret and critically evaluate statistical analyses in research literature and experimental studies.
- Perform hypothesis testing and assess statistical significance in biological research.
- Use appropriate statistical software to analyze biological data and generate reports.
- Communicate statistical findings effectively to both technical and non-technical audiences.

COURSE CONTENT:

UNIT-I

10 Hrs

Introduction: Statistics, Biostatistics, Frequency distribution

Measures of central tendency: Mean, Median, Mode- Pharmaceutical examples **Measures of dispersion:** Dispersion, Range, standard deviation, Pharmaceutical problems

Correlation: Definition, Karl Pearson's coefficient of correlation, Multiple correlation - Pharmaceuticals examples

UNIT-II

12 Hrs

Regression: Curve fitting by the method of least squares, fitting the lines $y = a + bx$ and $x = a + by$, Multiple regression, standard error of regression– Pharmaceutical Examples

Probability: Definition of probability, Binomial distribution, Normal distribution, Poisson's distribution, properties - problems

Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, type-I, type - II errors, Standard error of mean (SEM) - Pharmaceutical examples

Parametric test: t-test (Sample, Pooled or Unpaired and Paired), ANOVA, (One way and Two way), Least Significance difference

UNIT-III

8 Hrs

Non Parametric tests: Wilcoxon Rank Sum Test, Mann-Whitney U test, Kruskal-Wallis test, Friedman Test

Graphs: Histogram, Pie Chart, Cubic Graph, response surface plot, Counter Plotgraph.

UNIT-IV

10 Hrs

Blocking and confounding system for Two-level factorials

Regression modeling: Hypothesis testing in Simple and Multiple regression models

Introduction to Practical components of Industrial and Clinical Trials Problems:



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Statistical Analysis Using Excel, SPSS, MINITAB[®], DESIGN OF EXPERIMENTS, R - Online Statistical Software's to Industrial and Clinical trial approach.

UNIT-V

6 Hrs

Design and Analysis of experiments:

Factorial Design: Definition, 2^2 , 2^3 design. Advantage of factorial design **Response Surface methodology:** Central composite design, Historical design, Design Optimization Techniques

Textbooks:

1. Introduction to Biostatistics and Research Methods, 5th edition by P.S.S. Sundhar Rao and J. Richard, PHI publishers.
2. Fundamentals of Biostatistics, Khan and Khanum, Ukaaz publications, Hyderabad.

Recommended Books :

1. Pharmaceutical statistics- Practical and clinical applications, 5th edition, Sanford Bolton, Publisher Marcel Dekker Inc. New York.
2. Fundamental of Statistics – Himalaya Publishing House, 7th edition, S.C.Guptha.
3. Design and Analysis of Experiments – PHI Learning Private, Eastern economy edition, Limited, R. Pannerselvam.
4. Design and Analysis of Experiments– Wiley, 10th edition, Douglas C.Montgomery.



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II Year – I Semester

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**UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND
ETHICAL HUMAN CONDUCT**

Course Objectives:

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

- Define the terms like Natural Acceptance, Happiness and Prosperity (L1, L2)
- Identify one's self, and one's surroundings (family, society nature) (L1, L2)
- Apply what they have learnt to their own self in different day-to-day settings in real life (L3)
- Relate human values with human relationship and human society. (L4)
- Justify the need for universal human values and harmonious existence (L5)
- Develop as socially and ecologically responsible engineers (L3, L6)

Course Topics

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

UNIT I Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)

Lecture 2: Understanding Value Education

Tutorial 1: Practice Session PS1 Sharing about Oneself

Lecture 3: self-exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations



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Tutorial 2: Practice Session PS2 Exploring Human Consciousness

Lecture 5: Happiness and Prosperity – Current Scenario

Lecture 6: Method to Fulfill the Basic Human Aspirations

Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II

Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7: Understanding Human being as the Co-existence of the self and the body.

Lecture 8: Distinguishing between the Needs of the self and the body

Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.

Lecture 9: The body as an Instrument of the self

Lecture 10: Understanding Harmony in the self

Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self

Lecture 11: Harmony of the self with the body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III

Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV
session)

Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT V

Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct



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Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions for UNIT I – Introduction to Value Education

PS1 Sharing about Oneself

PS2 Exploring Human Consciousness

PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being

PS4 Exploring the difference of Needs of self and body

PS5 Exploring Sources of Imagination in the self

PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust

PS8 Exploring the Feeling of Respect

PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

READINGS:

Textbook and Teachers Manual

a. The Textbook

R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

R R Gaur, R Asthana, G P Bagaria, *Teachers' Manual for A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2



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Reference Books

1. *Jeevan Vidya: Ek Parichaya*, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – Pandit Sunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

Mode of Conduct:

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than "extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.



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Online Resources:

1. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf>
2. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf>
3. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf>
4. <https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%202023.pdf>
5. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf>
6. <https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf>
7. <https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf>
8. <https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385>
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview



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II Year – I Semester

L	T	P	C
3	0	0	3

ENGINEERING MECHANICS

PRE-REQUISITES: Engineering mechanics and mathematics

Course Objectives:

- To get familiarized with different types of force systems.
- To draw accurate free body diagrams representing forces and moments acting on a body to analyze the equilibrium of system of forces.
- To teach the basic principles of center of gravity, centroid and moment of inertia and determine them for different simple and composite bodies.
- To apply the Work-Energy method to particle motion.
- To understand the kinematics and kinetics of translational and rotational motion of rigid bodies.

Course Outcomes:

On Completion of the course, the student should be able to

CO1: Understand the fundamental concepts in mechanics and determine the frictional forces for bodies in contact.

CO2: Analyze different force systems such as concurrent, coplanar and spatial systems and calculate their resultant forces and moments.

CO3: Calculate the centroids, center of gravity and moment of inertia of different geometrical shapes.

CO4: Apply the principles of work-energy and impulse-momentum to solve the problems of rectilinear and curvilinear motion of a particle.

CO5: Solve the problems involving the translational and rotational motion of rigid bodies.

UNIT I

Introduction to Engineering Mechanics Basic Concepts. Scope and Applications

Systems of Forces: Coplanar Concurrent Forces Components in Space Resultant Moment of Force and its Application Couples and Resultant of Force Systems. Friction: Introduction, limiting dry friction, coefficient of friction, Cone of Static friction.

UNIT II

Equilibrium of Systems of Forces:

Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses. Principle of virtual work with simple examples

UNIT III

Centroid: Centroids of simple figures (from basic principles) Centroids of Composite Figures. Centre of Gravity: Centre of gravity of simple body (from basic principles), Centre of gravity of composite bodies, Pappus theorems.



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Area Moments of Inertia: Definition Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.

Mass Moment of Inertia: Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, Mass Moment of Inertia of composite bodies.

UNIT IV

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics Principle - Work Energy method and applications to particle motion-Impulse Momentum method.

UNIT V

Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method.

Textbooks:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., , McGraw Hill Education 2017. 5th Edition.
2. Engineering Mechanics, P.C.Dumir- S.Sengupta and Srinivas V veeravalli , University press. 2020. First Edition.
3. A Textbook of Engineering Mechanics, S.S Bhavikatti. New age international publications 2018. 4th Edition.

Reference Books:

1. Engineering Mechanics, Statics and Dynamics, Rogers and M A. Nelson., McGraw Hill Education. 2017. First Edition.
2. Engineering Mechanics, Statics and Dynamics, I.H. Shames., PHI, 2002. 4th Edition.
3. Engineering Mechanics, Volume-I: Statics, Volume-II: Dynamics, J. L. Meriam and L. G. Kraige., John Wiley, 2008. 6th Edition.
4. Introduction to Statics and Dynamics, BasudevBattachatia, Oxford University Press, 2014. Second Edition
5. Engineering Mechanics: Statics and Dynamics, Hibbeler R.C., Pearson Education, Inc., New Delhi, 2022, 14th Edition



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PHARMACEUTICAL ENGINEERING - I

L	T	P	C
3	0	0	3

PRE-REQUISITE: Pharmaceutical Engineering

COURSE OUTCOMES:

- To understand the principles of fluid flow, including types of manometers, Reynolds number, Bernoulli's theorem, flow measurement devices and distillation procedures.
- To understand the objectives and mechanisms of size reduction and size separation processes, including the operation and applications of various mills, sieves, and size separation equipment.
- To gain knowledge of drying principles and equipment, as well as mixing techniques for solid, liquid, and semisolid materials.
- To understand the principles and applications of filtration and centrifugation processes, and various filtration and centrifugation equipment.
- The materials used in pharmaceutical plant construction, including their properties and corrosion prevention techniques, ensuring the selection of appropriate materials for pharmaceutical applications.

COURSE OBJECTIVES: Upon completion of the course student shall be able:

1. To know various unit operations used in Pharmaceutical industries.
2. To understand the material handling techniques.
3. To perform various processes involved in pharmaceutical manufacturing process.
4. To carry out various tests to prevent environmental pollution.
5. To appreciate and comprehend significance of plant lay out design for optimum use of resources.
6. To appreciate the various preventive methods used for corrosion control in Pharmaceutical industries.

COURSE CONTENT:

UNIT-I

8 Hrs

Flow of fluids: Types of manometers, Reynolds number and its significance, Bernoulli's theorem and its applications, Energy losses, Orifice meter, Venturimeter, Pitot tube and Rotometer.

Distillation: Basic Principles and methodology of simple distillation, flash distillation, fractional distillation, distillation under reduced pressure, steam distillation & molecular distillation.

UNIT-II

10 Hrs

Size Reduction: Objectives, Mechanisms & Laws governing size reduction, factors affecting size reduction, principles, construction, working, uses, merits and demerits of Hammer mill, ball mill, fluid energy mill, Edge runner mill & end runner mill.

Size Separation: Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation Principles, construction, working, uses, merits and demerits of Sieve shaker, cyclone separator, Air separator, Bag filter & elutriation tank.

UNIT- III

10 Hrs

Drying: Objectives, applications & mechanism of drying process, measurements & applications of Equilibrium Moisture content, rate of drying curve. principles, construction,



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working, uses, merits and demerits of Tray dryer, drum dryer, spray dryer, fluidized bed dryer, vacuum dryer, freeze dryer.

Mixing: Objectives, applications & factors affecting mixing, Difference between solid and liquid mixing, mechanism of solid mixing, liquids mixing and semisolids mixing. Principles, Construction, Working, uses, Merits and Demerits of Double cone blender, twin shell blender, ribbon blender, Sigma blade mixer, planetary mixers, Propellers, Turbines, Paddles & Silverson Emulsifier.

UNIT-IV

10 Hrs

Filtration: Objectives, applications, Theories & Factors influencing filtration, filter aids, filter medias. Principle, Construction, Working, Uses, Merits and demerits of plate & frame filter, filter leaf, rotary drum filter, Meta filter & Cartridge filter, membrane filters and Seidtz filter.

Centrifugation: Objectives, principle & applications of Centrifugation, principles, construction, working, uses, merits and demerits of Perforated basket centrifuge, Non-perforated basket centrifuge, semi continuous centrifuge & super centrifuge.

UNIT- V

8 Hrs

Materials of pharmaceutical plant construction, Corrosion and its prevention: Factors affecting during materials selected for Pharmaceutical plant construction, Theories of corrosion, types of corrosion and their prevention. Ferrous and nonferrous metals, inorganic and organic non metals, basic of material handling systems.

Recommended Books:

1. Introduction to chemical engineering – Walter L Badger & Julius Banchemo, Latest edition.
2. Solid phase extraction, Principles, techniques and applications by Nigel J.K. Simpson- Latest edition.
3. Unit operation of chemical engineering – McCabe Smith, Latest edition.
4. Pharmaceutical engineering principles and practices – C.V.S Subrahmanyam et al., Latest edition.
5. Remington practice of pharmacy- Martin, Latest edition.
6. Theory and practice of industrial pharmacy by Lachmann., Latest edition.
7. Physical pharmaceutics- C.V.S Subrahmanyam et al., Latest edition.
8. Cooper and Gunn's Tutorial pharmacy, S.J. Carter, Latest edition.



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THERMODYNAMICS FOR PHARMACEUTICAL ENGINEERS

PRE-REQUISITES: Material and Energy Balance Computations.

COURSE OBJECTIVES:

To study the basic concepts of laws of thermodynamics, thermodynamic properties and phase and chemical equilibrium.

COURSE OUTCOMES:

The student will be able

1. Describe laws of thermodynamics and their applications.
2. Evaluate different types of property including entropy and its calculation.
3. Evaluate the thermodynamic properties of ideal and non-ideal solutions.
4. Analyze the procedures for estimating the thermodynamic properties and perform thermodynamic calculations oriented to the analysis of chemical equilibrium reactions.

Course Content:

UNIT-I

10 Hrs

Laws of thermodynamics: First law of thermodynamics - Types of energy, work, heat and energy changes, and applications of first law to different processes. Second law of thermodynamics and its applications - Entropy, reversible and irreversible processes, Carnot cycle, T-S diagrams, enthalpy of mixing and disorder; refrigeration and liquefaction.

UNIT-II

10 Hrs

Thermodynamic properties of fluids and their interrelationship: PVT behavior of pure substances; Equation of state; Generalized correlations and acentric factor; PVT behavior of mixtures; Thermodynamics charts; Estimation of thermodynamic properties. Thermodynamic properties and relations among them, mathematical relationships among basic properties, Maxwell relations.

UNIT-III

8 Hrs

Solution properties - Partial molar properties and chemical potential, concept of fugacity and activity and their calculations, ideal and non-ideal solutions, Gibbs - Duhem equations, property change of mixing and excess properties.

UNIT-IV

8 Hrs

Phase equilibria - Phase rule, fundamentals of vapor - liquid equilibria, Vanlaar, Margules and Wilson equations for binary mixture, liquid - liquid, solid - liquid and solid - vapor equilibria.

UNIT-V

10 Hrs

Chemical equilibrium: Chemical equilibrium constants; Homogeneous and heterogeneous reactions; Standard Gibbs free energy change; Equilibrium conversion in single and multiple reactions Statistical thermodynamics: Distribution of molecular states, internal energy and entropy; Partition function; Estimation of mean energies, heat capacities, equation of state, residual entropies, and equilibrium constant.

TEXT BOOKS:

1. J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engineering



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Thermodynamics”, Mc.Graw Hill, 1998.

2. K.V.Narayanan, “A textbook of Chemical Engineering Thermodynamics”, Prentice Hall of India Ltd., 2001.

REFERENCES:

1. T.E. Daubert, “Chemical Engineering Thermodynamics “, Mc.Graw Hill, 1985.
2. B.G.Kyle, “Chemical and Process Thermodynamics”, Prentice Hall of India Ltd., 1992.
3. Stanley.M. Walas, “Phase Equilibria in Chemical Engineering”, Butterworth Publishers, 1985.
4. R.C.Reid, J.M. Prausnitz and B.E. Poling, “The Properties of Gases and Liquids”, Mc.Graw Hill, IV Edition, 1988.
5. Y.V.C.Rao, "An Introduction to Thermodynamics”, Wiley Eastern, 1994.

Web References:

1. <http://link.springer.com/book>
2. <http://www.thphys.physics.ox.ac.uk>
3. <http://www.sciencedirect.com/science>
4. <http://www.e-booksdirectory.com>

E-TEXT BOOKS:

1. <http://nptel.ac.in/downloads/103101004/>
2. <http://www.cpp.edu/~lllee/TK303.pdf>
3. https://www.researchgate.net/publication/228381252_Introductory_Chemical_Engineering_Thermodynamics/
4. <http://www.zuj.edu.jo/download/chemical-engineering-thermodynamics-solution-manual.pdf/>



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

PHARMACEUTICAL ENGINEERING

(R23-IInd YEAR COURSE STRUCTURE & SYLLABUS)

II Year – I Semester

L	T	P	C
0	0	3	1.5

ENGINEERING MECHANICS LAB

Course Objectives: The students completing the course are expected to:

- Verify the Law of Parallelogram and Triangle of Forces.
- Determine the coefficients of friction of Static and Rolling friction and Centre of gravity of different plane Lamina.
- Analyse the system of Pulleys and Moment of Inertia of Compound Pendulum and Flywheel.

Course Outcomes:

CO1: Evaluate the coefficient of friction between two different surfaces and between the inclined plane and the roller.

CO2: Verify Law of Polygon of forces and Law of Moment using force polygon and bell crank lever.

CO3: Determine the Centre of gravity and Moment of Inertia of different configurations.

CO4: Verify the equilibrium conditions of a rigid body under the action of different force systems.

Students have to perform any 10 of the following Experiments:

List of Experiments:

1. Verification of Law of Parallelogram of Forces.
2. Verification of Law of Triangle of Forces.
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium using universal force table.
4. Determination of coefficient of Static and Rolling Frictions
5. Determination of Centre of Gravity of different shaped Plane Lamina.
6. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non- concurrent, parallel force system with the help of a simply supported beam.
7. Study of the systems of pulleys and draw the free body diagram of the system.
8. Determine the acceleration due to gravity using a compound pendulum.
9. Determine the Moment of Inertia of the compound pendulum about an axis perpendicular to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.
11. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever.

References:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022.

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II Year – I Semester

L	T	P	C
0	0	3	1.5

PHARMACEUTICAL ENGINEERING – I LAB

PRE-REQUISITES: Pharmaceutical engineering equipments

COURSE OBJECTIVES:

To provide knowledge on distillators, dryers, particles size, and various mechanical unit operations.

COURSE OUTCOMES:

1. Steam distillation – To calculate the efficiency of steam distillation.
2. To determine the overall heat transfer coefficient by heat exchanger.
3. Construction of drying curves (for calcium carbonate and starch).
4. Determination of moisture content and loss on drying.
5. Determination of humidity of air – i) From wet and dry bulb temperatures ii) Dew point method.
6. Description of Construction working and application of Pharmaceutical Machinery such as rotary tablet machine, fluidized bed coater, fluid energy mill, dehumidifier.
7. Size analysis by sieving – To evaluate size distribution of tablet granulations – Construction of various size frequency curves including arithmetic and logarithmic probability plots.
8. Size reduction: To verify the laws of size reduction using ball mill and determining Kicks, Rittinger's, Bond's coefficients, power requirement and critical speed of Ball Mill.
9. Demonstration of colloid mill, planetary mixer, fluidized bed dryer, freeze dryer and such other major equipment.
10. Factors affecting Rate of Filtration and Evaporation (Surface area, Concentration and Thickness/ viscosity)
11. To study the effect of time on the Rate of Crystallization.
12. To calculate the uniformity Index for given sample by using Double Cone Blender.



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II Year – I Semester

SOFT SKILLS

L	T	P	C
0	1	2	2

Course Objectives:

- To prepare to face global competition for employment and excellence in profession.
- To help the students understand and build interpersonal and interpersonal skills that will enable them to lead meaningful professional life.

UNIT – 1: INTRODUCTION

Introduction- Emergence of life skills, Definition & Meaning, Importance& need, reasons for skill gap, Analysis--Soft Skills vs Hard skills, Linkage between industry and soft skills, Challenges, Personality Developments. Soft Skills, Soft Skills vs English - Improving Techniques.

UNIT – II: Intra-Personal:

Definition-Meaning – Importance-SWOT analysis, Johari windows - Goal Setting- quotient skills - Emotional Intelligence- Attitudinal skills - Right thinking- Problem Solving-Time management, stress management.

UNIT – III: Inter-Personal:

Definition – Meaning – Importance-Communications skills- Team Work, managerial skills -Negotiation skills- Leadership skills, corporate etiquettes.

UNIT – IV: Verbal Skills:

Definition and Meaning-Listening skills, need- types, advantages, Importance-Improving Tips for Listening, Speaking, need- types, advantages, Importance- Improving Tips, Reading- Writing Skills, Report, Resume, statement of purpose, need- types, advantages, Importance-Improving Tips .

UNIT – V: Non Verbal Skills& Interview skills

Definition and Meaning – Importance- Facial Expressions- Eye Contact – Proxemics- Haptics -Posture, cross cultural body language, body language in interview room, appearance and dress code – Kinetics- Para Language - tone, pitch, pause, neutralization of accent, use of appropriate language, Interview skills, interview methods and questions.

Text Books:

- 1) Sherfield, M. Robert at al, Cornerstone Developing Soft Skills, 4/e, Pearson Publication, New Delhi, 2014.
- 2) Alka Wadkar, Life Skills for Success, 1/e, Sage Publications India Private Limited, 2016.

Reference Books:

1. Sambaiah.M. Technical English, Wiley publishers India. New Delhi. 2014.
2. Gangadhar Joshi, From Campus to Corporate, SAGE TEXT.
3. Alex.K, Soft Skills, 3rd ed. S. Chand Publication, New Delhi, 2014.
4. Meenakshi Raman and Sangita Sharma, Technical Communication: Principle and Practice, Oxford University Press, 2009.
5. Shalini Varma, Body Language for Your Success Mantra, 4/e, S. Chand Publication, New Delhi, 2014.
6. Stephen Covey, Seven Habits of Highly Effective People, JMD Book, 2013.



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Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc20_hs60/preview
- <http://www.youtube.com/@softskillsdevelopment6210>
- https://youtube.com/playlist?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q&si=Fs05Xh8ZrOPsR8F4
- <https://www.coursera.org/learn/people-soft-skills-assessment?language=English>
- <https://www.edx.org/learn/soft-skills>

Course Outcomes:

COs	Statements	Blooms Level
CO1	Assimilate and understood the meaning and importance of soft skills and learn how to develop them.	L1
CO2	Understand the significance of soft skills in the working environment for professional excellence.	L2
CO3	Prepare to undergo the placement process with confidence and clarity.	L3
CO4	Ready to face any situation in life and equip themselves to handle them effectively.	L6
CO5	Understand and learn the importance of etiquette in both professional and personal life	L2



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II Year – I Semester

ENVIRONMENTAL SCIENCE

L	T	P	C
2	0	0	-

Course Objectives:

- To make the students to get awareness on environment
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day-to-day activities of human life
- To save earth from the inventions by the engineers.

UNIT – I

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

UNIT – II

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

- a. Forest ecosystem.
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and Its Conservation : Introduction and Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution: Definition, Cause, effects and control measures of:

- a. Air Pollution.
- b. Water pollution
- c. Soil pollution
- d. Marine pollution
- e. Noise pollution
- f. Thermal pollution
- g. Nuclear hazards



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Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V

Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Textbooks:

1. Erach Bharucha, Text book of Environmental Studies for Undergraduate Courses, Universities Press (India) Private Limited, 2019.
2. Palaniswamy, Environmental Studies, 2/e, Pearson education, 2014.
3. S.Azeem Unnisa, Environmental Studies, Academic Publishing Company, 2021.
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, SciTech Publications (India), Pvt. Ltd, 2010.

Reference Books:

1. Deeksha Dave and E.Sai Baba Reddy, Textbook of Environmental Science, 2/e, Cengage Publications, 2012.
2. M.Anji Reddy, “Textbook of Environmental Sciences and Technology”, BS Publication, 2014.
3. J.P. Sharma, Comprehensive Environmental studies, Laxmi publications, 2006.
4. J. Glynn Henry and Gary W. Heinke, Environmental Sciences and Engineering, Prentice Hall of India Private limited, 1988.
5. G.R. Chatwal, A Text Book of Environmental Studies, Himalaya Publishing House, 2018.
6. Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 1/e, Prentice Hall of India Private limited, 1991.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc23_hs155/preview
- <https://www.edx.org/learn/environmental-science/rice-university-ap-r->



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[environmental-science-part-3-pollution-and-resources?index=product&objectID=course-3a6da9f2-d84c-4773-8388-1b2f8f6a75f2&webview=false&campaign=AP%C2%AE+Environmental+Science+Part+3%3A+Pollution+and+Resources&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fenvironmental-science](https://www.edx.org/learn/environmental-science)

- <http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf>
- <https://www.youtube.com/watch?v=5QxxaVfgQ3k>

Course Outcomes:

COs	Statements	Blooms Level
CO1	Grasp multi disciplinary nature of environmental studies and various renewable and non-renewable resources.	L2
CO2	Understand flow and bio-geo- chemical cycles and ecological pyramids.	L2
CO3	Understand various causes of pollution and solid waste management and related preventive measures.	L2
CO4	Understand the rainwater harvesting, watershed management, ozone layer depletion and waste land reclamation.	L2
CO5	Illustrate the causes of population explosion, value education and welfare programmes.	L3



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II Year – II Semester

L	T	P	C
2	0	0	2

MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

Course Objectives:

- To inculcate the basic knowledge of microeconomics and financial accounting
- To make the students learn how demand is estimated for different products, input-output relationship for optimizing production and cost
- To Know the Various types of market structure and pricing methods and strategy
- To give an overview on investment appraisal methods to promote the students to learn how to plan long-term investment decisions.
- To provide fundamental skills on accounting and to explain the process of preparing financial statements.

Course Outcomes:

- Define the concepts related to Managerial Economics, financial accounting and management(L2)
- Understand the fundamentals of Economics viz., Demand, Production, cost, revenue and markets (L2)
- Apply the Concept of Production cost and revenues for effective Business decision (L3)
- Analyze how to invest their capital and maximize returns (L4)
- Evaluate the capital budgeting techniques. (L5)
- Develop the accounting statements and evaluate the financial performance of business entity (L5)

UNIT - I Managerial Economics

Introduction – Nature, meaning, significance, functions, and advantages. Demand-Concept, Function, Law of Demand - Demand Elasticity- Types – Measurement. Demand Forecasting-Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

UNIT - II Production and Cost Analysis

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least- cost combination– Short run and long run Production Function- Isoquants and Is costs, Cost & Break-Even Analysis - Cost concepts and Cost behaviour- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems).

UNIT - III Business Organizations and Markets

Introduction – Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition– Oligopoly-Price-Output Determination - Pricing Methods and Strategies



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UNIT - IV Capital Budgeting

Introduction – Nature, meaning, significance. Types of Working Capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals, Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

UNIT - V Financial Accounting and Analysis

Introduction – Concepts and Conventions- Double-Entry Bookkeeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). Introduction to Financial Analysis - Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

Textbooks:

1. Varshney & Maheswari: Managerial Economics, Sultan Chand.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH.

Reference Books:

1. Ahuja HI Managerial economics Schand.
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage.

Online Learning Resources:

<https://www.slideshare.net/123ps/managerial-economics-ppt>
<https://www.slideshare.net/rossanz/production-and-cost-45827016>
<https://www.slideshare.net/darkyla/business-organizations-19917607>
<https://www.slideshare.net/balarajbl/market-and-classification-of-market>
<https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396>
<https://www.slideshare.net/ashu1983/financial-accounting>



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II Year – II Semester

L	T	P	C
3	0	0	3

REACTION ENGINEERING FOR PHARMACEUTICAL ENGINEERS

PRE-REQUISITES: Thermodynamics for pharmaceutical engineers

COURSE OBJECTIVE: To provide a foundation on deriving rate expressions for series, parallel, reversible reactions, reactive design, non-ideal flow and catalysis.

COURSE OUTCOMES:

The student will be able to

1. Deriving rate expressions for series, parallel, reversible reactions
2. Explain product distribution in multiple reactions; recycle reactors and auto catalytic reactions.
3. Estimate characteristic features of non- ideal flow and mixing of fluids in reaction vessels.
4. Explain introductory aspects of the design for heterogeneous reacting systems.

Course content:

UNIT-I

10 Hrs

Overview of chemical reaction engineering: Classification of reactions, variables affecting the rate of reaction definition of reaction rate. Kinetics of homogenous reactions-concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

Interpretation of batch reactor data- constant volume batch reactor: Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data-general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions,

UNIT-II

10 Hrs

Constant volume batch reactor: Empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions irreversible reactions in series Intrinsic empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

First order reversible reactions, second order reversible reactions, reversible reactions in general, integral method, Differential method of analysis of data. Varying volume batch reactor-differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

UNIT-III

8 Hrs

Introduction to reactor design- General discussion, temperature and pressure effects, symbols and relationship between C_A and X_A . Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

Temperature and Pressure effects- Single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from



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thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

UNIT-IV

12 Hrs

Basics of non-ideal flow: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).

The dispersion model: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

Catalysis and Catalytic reactors: Catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step.

Heterogeneous reactions: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics-Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, and heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

UNIT-V

6 Hrs

Fluid-fluid reactions: kinetics- The rate equation. Fluid-particle reactions: kinetics-selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

TEXT BOOKS:

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999
2. Chemical Reactions and Chemical Reactors, 1st Edition, George W. Roberts, Wiley, 2015.

REFERENCES:

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981
3. Fundamentals of Chemical Reactor Engineering: A Multi-Scale Approach, First Edition. Timur Doğu and Gülşen Doğu, Published 2022 by John Wiley & Sons, Inc.
4. Aris, R. (1989). Elementary Chemical Reactor Analysis. Boston: Butter worths.



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II Year – II Semester

L	T	P	C
3	0	0	3

HEAT TRANSFER FOR PHARMACEUTICAL ENGINEERS

PRE-REQUISITES: Material and energy balance computations

COURSE OBJECTIVES: This course helps in making the student understand various modes of heat transfer, heat transfer with and without phase change, heat transfer equipment, and radiation.

COURSE OUTCOMES: The student will be able to

1. Classify the modes of heat transfer
2. Identify the Natural Convection, Forced Convection and Radiation
3. Describe heat transfer laws for heat Exchangers
4. Differentiate the heat exchanger performance for co-current and counter –current flows
5. Explain Heat transfer Coefficients, efficiency of heat exchangers and the Heat Radiation in detail. Classify the types of heat exchanger equipments and evaporator along with feeding methods

Course content

UNIT-I

6 Hrs

Introduction: Nature of heat flow, conduction, convection, natural and forced convection, radiation. Heat transfer by conduction in Solids: Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres

UNIT-II

10Hrs

Principles of heat flow in fluids: Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

UNIT-III

10 Hrs

Heat Transfer to Fluids without Phase change: Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes. Natural convection: Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer

UNIT-IV

8 Hrs

Heat Transfer to Fluids with Phase change: heat transfer from condensing vapors, heat transfer to boiling liquids. Heat exchange equipment: General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchangers effectiveness (NTU method)

UNIT-V

12 Hrs



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Evaporators: Evaporators, performance of tubular evaporators, capacity and economy single and multiple effect evaporator, method of feeding, vapors recompression. Radiation: Radiation: Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semitransparent materials, combined heat transfer by conduction, convection and radiation.

TEXT BOOKS:

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

REFERENCES:

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, J.P.Holman, 9th Edition, Tata McGraw-Hill, 2008
3. A Text Book on Heat Transfer, S.P. Sukhatme, 5th Edition, Universities Press (India) Pvt. Ltd., 2005.
4. Heat Transfer: Principles and Applications, BinayDutta, K., 1st Edition, Phi Learning, 2009.



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PHARMACEUTICAL ENGINEERING

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II Year – II Semester

L	T	P	C
3	0	0	3

PHYSICAL PHARMACEUTICS

PRE-REQUISITES: Physics and Chemistry

COURSE OBJECTIVES: To know important physical properties of drug molecules, interfacial phenomenon, complexation, types of colloids and its properties, and micromeritics.

COURSE OUTCOMES: To student will be able to

1. Illustrate the important physical properties of drug molecules, phase value & its importance.
2. Identify Different electrolytes and non-electrolyte solutions, importance of pH and drug research.
3. Analyze industrial phenomenon of liquids, rate & order of reactants.
4. Interpret micromeritics, and types of colloids and their properties.

Course content:

UNIT-I

8 Hrs

Ionic Equilibria: Modern theories of acids and bases. Sorensen's pH scale, calculation of pH, acidity constants. Buffers and buffered isotonic systems. The buffer equation, buffer capacity, buffers in pharmaceuticals and biologics, buffered isotonic, methods of adjusting tonicity and pH.

UNIT-II

8Hrs

Solubility and distribution phenomenon: Solvent – solute interactions, factors influencing solubility of gases in liquids, solubility of solids in liquids and solubility of liquids in liquids, solids. Distribution coefficient: applications and limitations influence of molecular association and dissociation on partition coefficient, preservative action of weak acids in oil water system.

UNIT-III

10 Hrs

Interfacial phenomenon: Definition, method of determination. Significance in Pharmacy. Liquid interfaces, adsorption at liquid interfaces. Surface active agent's classification, properties, applications HLB. Adsorption at solid interfaces. Electric properties at interfaces – Zeta potential and its importance. Complexation: Types of complexes, metal, organic and inclusion complexes, methods of analysis. Colloids: classification, purification, protective colloid action, properties.

UNIT-IV

12 Hrs

Coarse dispersions: Suspensions – interfacial properties of suspended particles, settling in suspensions. Formulation and evaluation, rheological properties of suspensions.

Emulsions: Theories of emulsification, physical stability of emulsions, preservation of emulsions, rheological properties of emulsions. Semisolids: classification, properties.

Gels: classification, concept of synthesis and swelling.

UNIT-V

8 Hrs

Micromeritics: Particle size and size distribution, methods of determining particle size particle shape, particle number, surface area – methods of determining surface area, derived properties of powders – their significance.



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TEXT BOOKS:

1. Essentials of physical pharmacy by CVS Subrahmanyam, 2nd Edition, 2017, publisher:
Vallabh Prakashan.
2. Vallabh Prakashan.
3. Text book of physical pharmaceutics by CVS Subrahmanyam, 2nd Edition, 2000, publisher: Vallabh Prakashan.
4. Martin's Physical Pharmacy and Pharmaceutical Sciences edited by PJ Sinko; 6TH edition, 2006, publisher: Lippincott Williams & Wilkins.
5. Tutorial Pharmacy by Cooper and Gunn, edited by S.J. Carter; 6th edition, Publisher: CBS Publishers. 5. Remington's The Science and Practice of Pharmacy, volume I and volume II, 22nd edition.

REFERENCES:

1. Bentley's Textbook of Pharmaceutics by E.A. Rawlins, publisher: Bailliere Tindall, 1977.
2. Physical pharmacy Practical text by Guru Prasad Mohanta and Prabal Kumar Manna, Published by Pharma book syndicate.
3. Essentials of physical pharmacy by Derle D.V. published by pharma book syndicate.



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II Year – II Semester

L	T	P	C
3	0	0	3

PRINCIPLES OF MICROBIOLOGY AND BIOCHEMISTRY

PRE-REQUISITES: Biology and Chemistry

COURSE OBJECTIVES: To deal with the various aspects of microorganisms their classification, morphology, cultivation, identification, sterility testing and to introduce students to biochemistry and biomolecules.

COURSE OUTCOMES: The student will be able to

1. Describe cultivation of microorganisms.
2. Describe sterilization of various pharmaceutical products, equipment, and culture media.
3. Illustrate sterility testing.
4. Explain biochemical organization in human system.

Course content:

UNIT-I

8 Hrs

Introduction to Microbiology: Origin, scope and discovery of microbiological world, Spontaneous generation theory. Pharmaceutical significance of protozoa, algae, fungi, bacteria and viruses. Characterization and identification of microorganisms.

Nutrition and Growth of Microbes: Nutritional requirements, Types of Nutrient media and growth Conditions and Nutritional types based on energy source. Isolation, cultivation (aerobic & anaerobic) and preservation of microorganisms, physiology of growth, bacterial growth curve, methods for determining bacterial numbers, mass and cell constituents

UNIT -II

8 Hrs

Control of Microorganisms: General Concepts, Inhibition of growth and killing, sterilization and Disinfection, antisepsis and sanitation, mode of action application & limitation of physical agents (moist and dry heat, radiation and filtration), chemical agents. Various types of disinfectants, factors affecting sterilization and disinfection, evaluation of antimicrobial activity, chemotherapeutic agents, mode of action and applications, drug resistance. pharmaceuticals and bio safety measures

UNIT-III

10 Hrs

a. Microbiological Assays: Principles and Methods involved in Assay of Antibiotics, Vitamins, Amino acids & Bio-Sensors in Analysis.

b. Microbial Source & applications of various pharma products like Antibiotics, vitamins. Amino acids, solvents, enzymes & genetic engineered products etc.

C. Sampling of the air in clean house in classified areas.

UNIT-IV

12 Hrs

Introduction to Biochemistry:

Biomembranes: Structure and molecular constituents of membrane, models proposed, function and properties of membrane, transport hypothesis: Active and Passive, facilitated transport, Na⁺, K⁺, H⁺ pumps. Glucose transport, osmoregulation.



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Biomolecules & Metabolism: Carbohydrates: Structure and classification & complex carbohydrates, biological role of carbohydrates. Metabolism: Glycolysis, glycogenolysis, gluconeogenesis, Krebs's cycle, glucuronic acid pathways.

Proteins: Introduction, functional classification. Amino acids: Classification, Physicochemical properties, optical activity, reaction with ninhydrin, formaldehyde, R-group amino acids. Essential, non-essential amino acids, deficiency. Metabolism: Urea cycle, deamination, Transamination, decarboxylation reactions of some important amino acids.

UNIT-V

8 Hrs

Enzymes: Introduction, classification, (according to the reaction catalysis and sources) properties, mechanism of action, and structure of enzymes, co-factor, active sites, Factors active substrates, pH ionic strength, conc., temperature. Enzyme inhibition (Competitive, Non-competitive, irreversible). Therapeutic uses of enzymes.

Lipids: Definition, Classification, Functions, Types of fatty acids and its biological role. Metabolism: Alpha, Beta, Gamma & Omega oxidations of fatty acids, bio-synthesis of fatty acids, cholesterol. Nucleic acids: Structure, classification, cell and biological functions, chemical composition, as genetic.

TEXT BOOKS:

1. Pelczar and Reid, Text Book of Microbiology, 3rd Edition, McGraw-Hill, 1971.
2. Anantha Narayan and JayramPanikar, Text Book of Microbiology, Orient Longman, Delhi. N.K. Jain, Pharmaceutical Microbiology.
3. D. Satyanarayan and U.Chakrapani, Biochemistry
4. Textbook of Biochemistry by Rama Rao.

REFERENCES:

1. Heritage, J Introductory Microbiology, published by the press syndicate of the university of Cambridge, 2000.
2. Nester, Anderson, Roberts, Pearsall, Microbiology, McGraw-Hill, 4th edition, McGraw Hill Publisher.
3. Hugo, W B Pharmaceutical Microbiology, 8th edition, published: Wiley-Blackwell.
4. Lodish, Harvey et.al., "Molecular Cell Biology," 6th Edition. W.H.Freeman, 2008.
5. Alberts, Bruce, "Molecular Biology of Cell", 5th Edition, Garland Science, 2008
6. Textbook of Biochemistry by Deb
7. Harper's Biochemistry by Robert K. Murry, Daryl K. Granner and Victor W. Rodwell.



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L	T	P	C
0	0	3	1.5

PHYSICAL PHARMACEUTICS LAB

PRE-REQUISITES: Physical Pharmaceutics

COURSE OBJECTIVES: To impart pertinent concepts pH solubility, flow properties of powders, fluid properties.

COURSE OUTCOMES:

1. Discuss the relation between pH and Solubility, and factors influencing the pH of buffer solutions.
2. Describe the factors influencing the solubility phenomenon and could be able to identify the types of complexes.
3. Explain how particles can be characterized and why these methods are important in pharmaceutical industry.
4. Analyze the different physical properties and influence of these particle characteristics in formulation of pharmaceutical products.

Lab Experiments

1. Phase diagram of phenol-water system.
2. Determination of flow properties of powders.
3. Determination of bulk density, true density and % porosity of powders.
4. Determination of angle of repose.
5. Preparation of selected buffers and determination of buffer capacity of acetate buffer.
6. Determination of partition coefficient of benzoic acid in benzene and water.
7. Study of complexation of copper and glycine by pH titration method.
8. Determination of surface tension of liquids.
9. Determination of CMC by drop count method.
10. Influence of additives (glycerol in aqueous phase) on the partition coefficient.
11. Determination of HLB of a surfactant.
12. Determination particle size by gravity sedimentation Anderson's apparatus.



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L	T	P	C
0	0	3	1.5

MICROBIOLOGY & BIOCHEMISTRY LAB

PRE-REQUISITES: Principles of Microbiology and Biochemistry

COURSE OBJECTIVES: To impart the basic concepts of morphology of microbes, preparation of culture media, characterization of microbes and assay of compounds

COURSE OUTCOMES: The student

1. Can be able to differentiate Microorganisms
2. Can be able to perform sterilization techniques in labs, Hospitals etc
3. Can be able to Characterize Microorganisms
4. Can be able evaluate potency of commercial Antibiotics, vitamins, amino acids

Lab Experiments

1. Microscopy; Scientific Inquiry; Mounting Microorganism and Study morphology and structure of different microbes.
2. Perform all physical sterilization Techniques mandated in Biosafety class-II laboratory
3. Preparation of various culture media
4. Cultivation of microbes and observation of colony characteristics.
5. Characterization of microbes by Gram staining technique & Acid fast staining technique.
6. Evaluation of commercial disinfectant by phenol-coefficient test.
7. Assay of antibiotic.
8. Assay of Vitamins.
9. Assay of amino acids.
10. Preparation of buffer solution and measurement of pH
11. Qualitative analysis of carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose and starch)
12. Identification tests for Proteins (albumin and Casein)

TEXT BOOKS:

1. Microbiology: A Laboratory Manual, James G. Cappuccino
2. Microbiology: An Introduction, 12th Edition, Gerard J. Tortora, Berdell R. Funke and Christine
3. Practical Biochemistry by R.C. Gupta and S. Bhargavan.
4. Introduction of Practical Biochemistry by David T. Plummer. (3rd Edition)
5. Practical Biochemistry for Medical students by Rajagopal and Ramakrishna.



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II Year – II Semester

ORGANISATIONAL BEHAVIOUR

L	T	P	C
0	1	2	2

PRE-REQUISITE:

COURSE OBJECTIVES:

- To enable student's comprehension of organizational behavior
- To offer knowledge to students on self-motivation, leadership and management
- To facilitate them to become powerful leaders
- To Impart knowledge about group dynamics
- To make them understand the importance of change and development

COURSE OUTCOMES:

- Define the Organizational Behaviour, its nature and scope.
- Understand the nature and concept of Organizational behaviour
- Apply theories of motivation to analyse the performance problems
- Analyse the different theories of leadership
- Evaluate group dynamics
- Develop as powerful leader

Course content:

UNIT - I

8 Hrs

Introduction to Organizational Behavior

Meaning, definition, nature, scope and functions - Organizing Process – Making organizing effective – Understanding Individual Behaviour –Attitude -Perception - Learning – Personality.

UNIT - II

10 Hrs

Motivation and Leading

Theories of Motivation- Maslow's Hierarchy of Needs - Herzberg's Two Factor Theory - Vroom's theory of expectancy – Mc Clelland's theory of needs–McGregor's theory X and theory Y– Adam's equity theory – Locke's goal setting theory– Alderfer's ERG theory.

UNIT - III

10 Hrs

Organizational Culture

Introduction – Meaning, scope, definition, Nature - Organizational Climate - Leadership - Traits Theory–Managerial Grid - Transactional Vs Transformational Leadership - Qualities of good Leader- Conflict Management -Evaluating Leader- Women and Corporate leadership.

UNIT - IV

10 Hrs

Group Dynamics

Introduction – Meaning, scope, definition, Nature- Types of groups - Determinants of group behavior - Group process – Group Development - Group norms - Group cohesiveness - Small Groups - Group decision making - Team building - Conflict in the organization– Conflict resolution



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UNIT – V

8 Hrs

Organizational Change and Development

Introduction –Nature, Meaning, scope, definition and functions- Organizational Culture - Changing the Culture – Change Management – Work Stress Management - Organizational management – Managerial implications of organization’s change and development

TEXTBOOKS:

1. Luthans, Fred, Organisational Behaviour, McGraw-Hill, 12 Th edition 2011
2. P Subba Ran, Organisational Behaviour, Himalya Publishing House 2017

REFERENCE BOOKS:

1. McShane, Organizational Behaviour, TMH 2009
2. Nelson, Organisational Behaviour, Thomson, 2009.
3. Robbins, P. Stephen, Timothy A. Judge, Organisational Behaviour, Pearson 2009.
4. Aswathappa, Organisational Behaviour, Himalaya, 2009

Online Learning Resources:

<https://www.slideshare.net/Knight1040/organizational-culture>

9608857s://www.slideshare.net/AbhayRajpoot3/motivation-165556714

<https://www.slideshare.net/harshrastogi1/group-dynamics-159412405>

<https://www.slideshare.net/vanyasingla1/organizational-change-development-26565951>



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L	T	P	C
1	0	2	2

DESIGN THINKING & INNOVATION

Course Objectives: The objectives of the course are to

- Bring awareness on innovative design and new product development.
- Explain the basics of design thinking.
- Familiarize the role of reverse engineering in product development.
- Train how to identify the needs of society and convert into demand.
- Introduce product planning and product development process.

UNIT – I Introduction to Design Thinking

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT - II Design Thinking Process

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT - III Innovation

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT - IV Product Design

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT – V Design Thinking in Business Processes

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

Textbooks:

1. Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2. Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2. Shrutin N Shetty, Design the Future, 1/e, Norton Press, 2018.



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3. William Lidwell, Kritin Holden, & Jill Butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4. Chesbrough, H., The era of open innovation, 2003.

Online Learning Resources:

- <https://nptel.ac.in/courses/110/106/110106124/>
- <https://nptel.ac.in/courses/109/104/109104109/>
- https://swayam.gov.in/nd1_noc19_mg60/preview
- https://onlinecourses.nptel.ac.in/noc22_de16/preview

Course Outcomes:

COs	Statements	Blooms Level
CO1	Define the concepts related to design thinking.	L1
CO2	Explain the fundamentals of Design Thinking and innovation.	L2
CO3	Apply the design thinking techniques for solving problems in various sectors.	L3
CO4	Analyse to work in a multidisciplinary environment.	L4
CO5	Evaluate the value of creativity.	L5